

FIRM:Your Firm
MADE BY:KJH DATE:05-21-2006
TITLE:Example RETWALL calculation

JOB NO.
CHECKED BY:

SHEET NO: 1
DATE:

=====

RETAINING WALL DESIGN:WINGWALLS

DESIGN DATA:

Wall design file:c:\DCALC\DEMO\DCALC9.IN

Design Method: Load Factor Design
Heel Design Load Factor=1.70
Toe and Stem Design Load Factor=1.70

Concrete strength, $f_c' = 3.50$ ksi
Reinforcing, $F_y = 60$ ksi

Minimum reinforcing steel ratio, $p_{min} = 0.00132$ (on gross area)

Bar clearances: 3.00 inches for bars cast above grade
2.00 inches for other bars

Soil behind wall is unsaturated. Dry earth weight = .119 kcf
Angle of internal friction= 30.00 degrees

Design for active earth pressure:

$$K_a = \cos 18.39 \times \frac{\cos 18.39 - (\cos 18.39^2 - \cos 30.00^2)^{.5}}{\cos 18.39 + (\cos 18.39^2 - \cos 30.00^2)^{.5}} = .398$$

$$P_a = .398 \times .119 = 0.047 \text{ kcf}$$

$$\text{Horizontal component of pressure} = \cos 18.39 \times 0.047 = 0.045 \text{ kcf}$$

For sliding check of spread footings (see '91 AASHTO Table 5.5.5B):

Interface:Undrained stiff cohesive soil

Friction factor= 0.000

Adhesion = .750 ksf

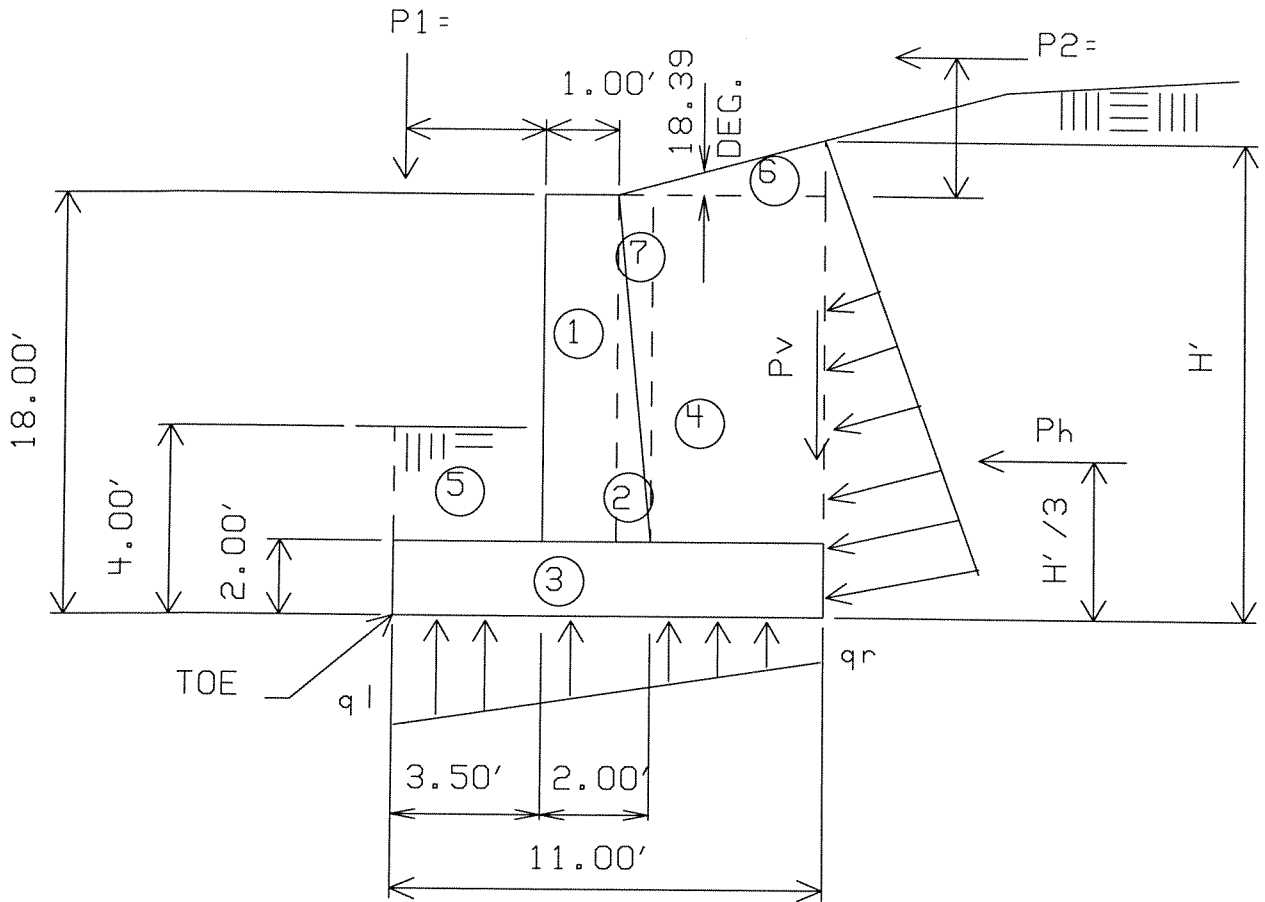
FIRM:Your Firm
 MADE BY:KJH DATE:05-21-2006
 TITLE:Example RETWALL calculation

JOB NO.
 CHECKED BY:

SHEET NO: 2
 DATE:

=====

RETAINING WALL DESIGN:WINGWALLS



STABILITY ANALYSIS:

Item	V	H	arm	Mtoe
1: 1.00 X 16.00 X .15 =	2.4		4.00	9.6
2: 1/2 X 1.0 X 16.0 X .15 =	1.2		4.83	5.8
3: 2.00 X 11.00 X .15 =	3.2		5.50	18.1
4: 5.50 X 16.00 X .11 =	10.5		8.25	87.1
5: 3.50 X 2.00 X .11 =	.8		1.75	1.4
6: 1/2x 2.16X 6.50 X .119=	.8		8.83	7.4
7: 1/2 X 1.0 X 16.0 X .11 =	.9		5.16	4.9
P1 =	0.0		3.50	0.0
P2 =		0.0	-18.00	0.0
Pe: 1/2x(20.1) ² x0.047= 9.7 k				
Ph=cos18.3 x 9.7 =		9.2	-6.72	-61.9
Pv=sin18.3 x 9.7 =	3.0		11.00	33.7
TOTALS =	23.1	9.2		106.3

Eccentricity, e = 106.3/ 23.1= 4.58 feet right of toe

FIRM:Your Firm
MADE BY:KJH DATE:05-21-2006
TITLE:Example RETWALL calculation

JOB NO.
CHECKED BY:

SHEET NO: 3
DATE:

=====

RETAINING WALL DESIGN:WINGWALLS

DETERMINE FOOTING PRESSURE:

Moment at centerline of footing,

$$M = 23.1 \times (11.00/2 - 4.58) = 21.10 \text{ k*ft}$$

$$q = 23.1/11.00 \pm 6 \times 21.10 / (11.00)^2$$
$$= 2.106 \pm 1.046$$

$$q_l = 2.106 + 1.046 = 3.153 \text{ ksf}$$

$$q_r = 2.106 - 1.046 = 1.059 \text{ ksf}$$

CHECK OVERTURNING:

Overturning moment, $M_o = 0.00 + 61.95 = 61.95$

Righting moment, $M_r = 9.60 + 5.80 + 18.14 + 87.11$
 $+ 1.46 + 7.44 + 0.00 + 33.73 = 168.28$

Safety factor against overturning,

$$SF = M_r / M_o = 168.28 / 61.95 = 2.716$$

CHECK SLIDING:

Available friction at base = $0.000 \times 23.1 \text{ k} + .750 \times 11.00' = 8.25 \text{ k}$

$$K_p = (1 + \sin 30.00) / (1 - \sin 30.00) = 2.99$$

$$P_p = .119 \times 2.99 = .359 \text{ kcf}$$

$$\text{Available passive pressure in front} = 1/2 \times .359 \text{ ksf} \times (4.000 \text{ ft})^2 = 2.87 \text{ k}$$

Safety factor against sliding (w/o passive pressure)

$$= 8.25 / 9.2 = .894$$

Safety factor against sliding (w/passive pressure)

$$= (8.25 + 2.87) / 9.2 = 1.207$$

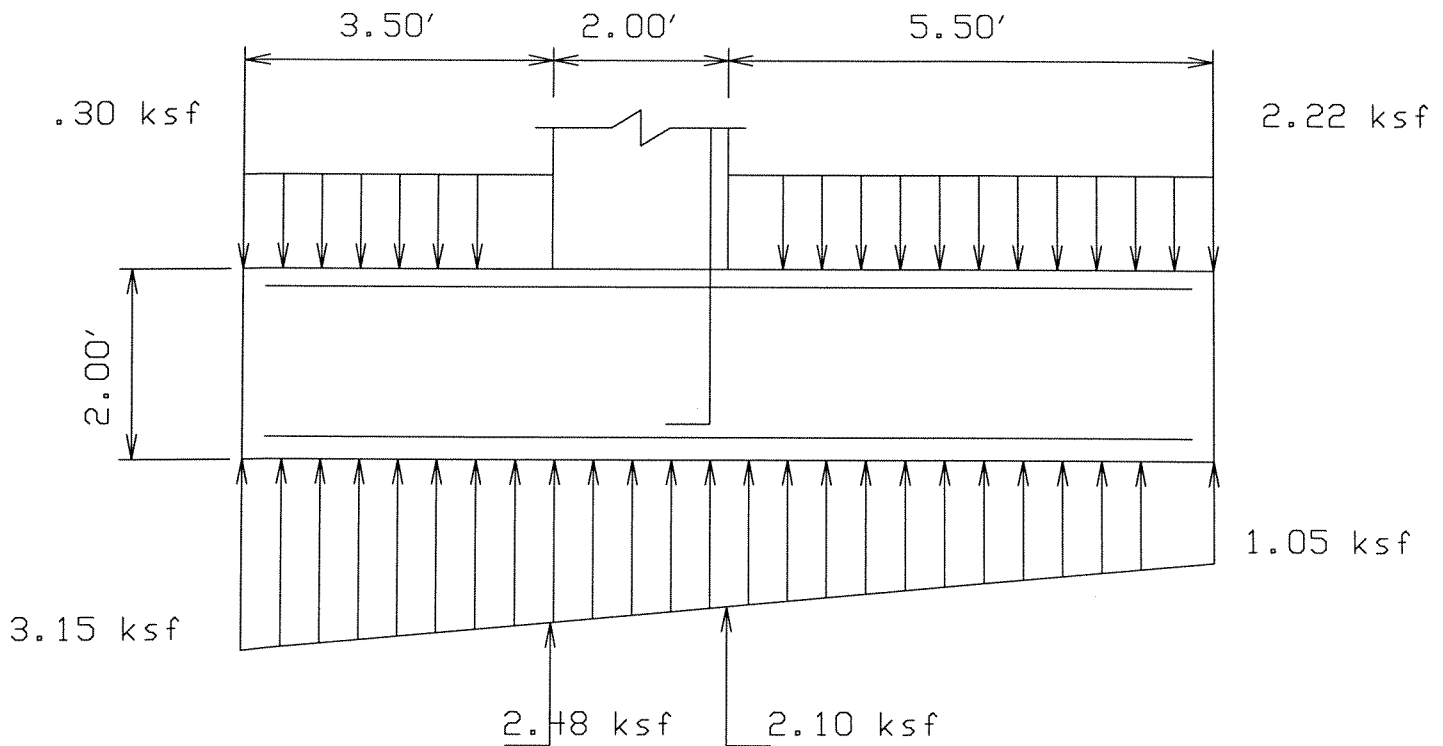
FIRM:Your Firm
 MADE BY:KJH DATE:05-21-2006
 TITLE:Example RETWALL calculation

JOB NO.
 CHECKED BY:

SHEET NO: 4
 DATE:

=====

RETAINING WALL DESIGN: WINGWALLS



FOOTING DESIGN DATA:

$F_y = 60.00 \text{ ksi}$, $f_c' = 3.50 \text{ ksi}$
 Allowable shear = $0.85 * 2 (3500)^{.5} = 100 \text{ psi}$
 Use the following load factors for footing design:
 Load factor for toe design = 1.70
 Load factor for heel design = 1.70

Minimum reinforcement ratio = 0.0013

$d = 12 \times 2.00 - (3.00 + 0.5) \text{ in} = 20.50 \text{ in}$ (bottom bars)
 $= 12 \times 2.00 - (2.00 + 0.5) \text{ in} = 21.50 \text{ in}$ (top bars)

LOADS ON TOP OF FOOTING:

Load on toe,
 (Neglect overburden on toe, due to possibility of erosion)
 Dead load footing = $2.00 \times 0.15 = .30 \text{ ksf}$

Load on heel,
 varies from $q = (18.00 - 2.00) \times .119 \text{ kcf} + .30 \text{ ksf} = 2.22 \text{ ksf}$
 to $q = (20.16 - 2.00) \times .119 \text{ kcf} + .30 \text{ ksf} = 2.47 \text{ ksf}$

FIRM:Your Firm
MADE BY:KJH DATE:05-21-2006
TITLE:Example RETWALL calculation

JOB NO.
CHECKED BY:

SHEET NO: 5
DATE:

=====

RETAINING WALL DESIGN: WINGWALLS

TOE DESIGN:

$$Mdl = .30 \times (3.50)^2 / 2 = 1.83 \text{ k*ft/ft}$$

Critical section for shear at 3.50 ft- 20.50in/12= 1.79 ft from toe
 $Vdl = .30 \times 1.79 = .53 \text{ k/ft}$

$$Mq = 1/2 \times 2.487 \times (3.50)^2 + 1/3 \times (3.15 - 2.487) \times (3.50)^2 = 17.95 \text{ k*ft/ft}$$

At critical section, $q = 3.15 - 1.79 \times (3.153 - 1.05) / 11.00 = 2.81 \text{ ksf}$
 $Vq = 2.81 \times 1.79 + 1/2 \times (3.15 - 2.81) \times 1.79 = 5.34 \text{ k/ft}$

$$V_{tot} = 5.34 - .53 = 4.80 \text{ k/ft}$$

$$\text{Factored shear, } Vu = 1.70 \times 4.80 = 8.17 \text{ k/ft}$$

$$\text{Shear stress} = 8.17 / (12 \times 20.50) \times 1000 = 31 \text{ psi} < 100 \text{ psi (OK)}$$

$$M_{tot} = 17.95 - 1.83 = 16.11 \text{ k*ft/ft}$$

By trial and error, compression block depth, $a = .50 \text{ in}$

$$As = 12 * M / (0.9 * Fy * (d - a/2))$$
$$= 12 \times 27.3 / (0.9 \times 60 \times (20.50 - .50/2))$$
$$= .30 \text{ in}^2 / \text{ft}$$

Check a:

$$a = As * Fy / (0.85 * Fc * b)$$
$$= .30 \times 60.00 / (0.85 \times 3.50 \times 12)$$
$$= .50 \text{ in (checks)}$$

Minimum reinforcement,

$$A_{min} = 200 / 60000 \times 20.50 \times 12 = .81 \text{ in}^2 / \text{ft}$$

or $= 1.33 \times .30 = .39 \text{ in}^2 / \text{ft}$

but not less than, $0.0013 \times 24.00 \times 12 = .38 \text{ in}^2 / \text{ft}$

| Toe reinforcement req'd= .39 sq. in/ft Bot. |

FIRM:Your Firm
MADE BY:KJH DATE:05-21-2006
TITLE:Example RETWALL calculation

JOB NO.
CHECKED BY:

SHEET NO: 6
DATE:

=====

RETAINING WALL DESIGN: WINGWALLS

HEEL DESIGN:

$$Mdl = 1/2 \times 2.22 \times (5.50)^2 + 1/3 \times (2.47 - 2.22) \times (5.50)^2 = 36.19 \text{ k*ft/ft}$$
$$Vdl = 1/2 \times (2.22 + 2.47) \times 5.50 = 12.92 \text{ k/ft}$$

Partial component of Pv acting on heel, Vpv = 1.13 k/ft
(acting from bottom of footing to 2.16' above footing)

Moment due to partial component of Pv,
 $Mpv = 1.13 \times 5.50 = 6.24 \text{ k*ft/ft}$

$$Mq = 1/2 \times 1.05 \times (5.50)^2 + 1/6 \times (2.10 - 1.05) \times (5.50)^2 = 21.3 \text{ k*ft/ft}$$
$$Vq = 1/2 \times (2.10 + 1.05) \times 5.50 = 8.70 \text{ k/ft}$$

$$V_{tot} = 12.92 + 1.13 - 8.70 = 5.35 \text{ k/ft}$$

Factored shear, $V_u = 1.70 \times 5.35 = 9.09 \text{ k*ft/ft}$
Shear stress = $9.09 / (12 \times 21.50) \times 1000 = 35 \text{ psi} < 100 \text{ psi (OK)}$

$$M_{tot} = 21.30 - 36.19 - 6.24 = -21.13 \text{ k*ft/ft}$$

Factored moment, $M_u = 1.70 \times (-21.13) = -35.92 \text{ k*ft/ft}$

By trial and error, compression block depth, $a = .63 \text{ in}$

$$A_s = 12 \times M / (0.9 \times F_y (d - a/2))$$
$$= 12 \times 35.9 / (0.9 \times 60 (21.50 - .63/2))$$
$$= .37 \text{ in}^2 / \text{ft}$$

Check a:

$$a = A_s \times F_y / (0.85 \times F_c \times b)$$
$$= .37 \times 60.00 / (0.85 \times 3.50 \times 12)$$
$$= .63 \text{ in (checks)}$$

Minimum reinforcement,

$$A_{min} = 200 / 60000 \times 21.50 \times 12 = .86 \text{ in}^2 / \text{ft}$$

or $= 1.33 \times .37 = .50 \text{ in}^2 / \text{ft}$
but not less than, $0.0013 \times 24.00 \times 12 = .38 \text{ in}^2 / \text{ft}$

| Heel reinforcement req'd = .50 sq. in/ft Top |

FIRM:Your Firm
 MADE BY:KJH DATE:05-21-2006
 TITLE:Example RETWALL calculation

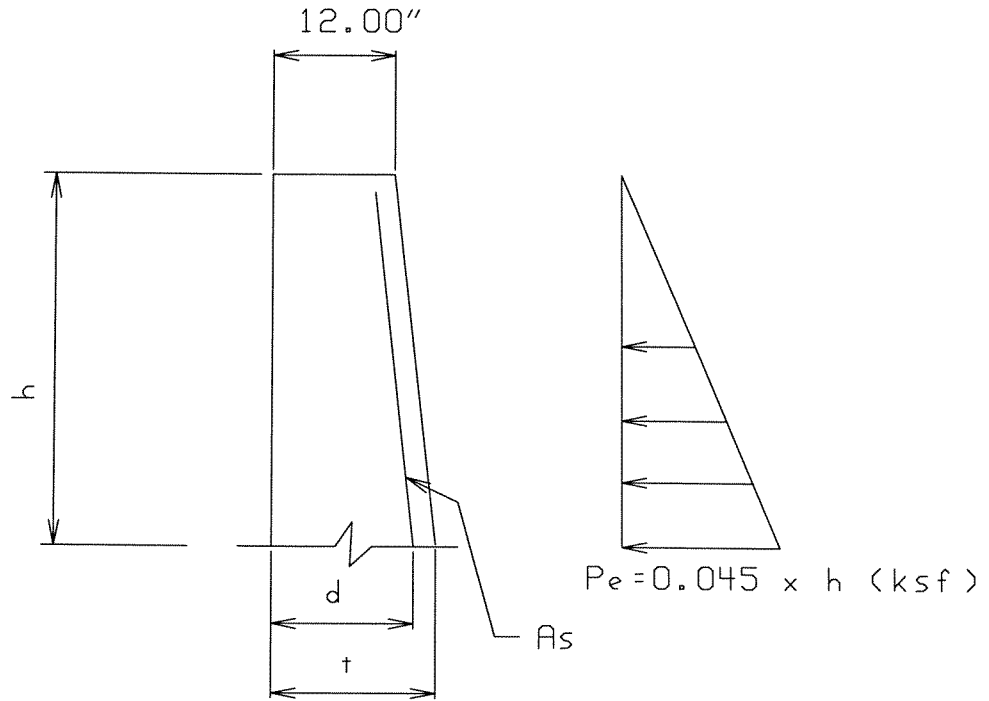
JOB NO.
 CHECKED BY:

SHEET NO: 7
 DATE:

=====

RETAINING WALL DESIGN:WINGWALLS

STEM DESIGN:



Load factor for stem design = 1.70

h (ft)	M (k*ft)	Mu (k*ft)	t (in)	d (in)	Reinforcement in back face (sq. in/ft)				
					As,req'd	4/3xAs Min.	Min ratio 200/Fy	Min. ratio 0.0013	Use As
0.0	0.0	0.0	12.00	9.50	0.00	0.00	.37	.19	.19
1.6	0.0	0.0	13.20	10.70	0.00	0.00	.42	.21	.21
3.2	.2	.4	14.40	11.90	0.00	0.01	.47	.22	.22
4.8	.8	1.4	15.59	13.09	0.02	0.03	.52	.24	.24
6.4	1.9	3.3	16.79	14.29	0.05	.06	.57	.26	.26
8.0	3.8	6.5	18.00	15.50	0.09	.12	.62	.28	.28
9.6	6.6	11.3	19.20	16.70	.15	.20	.66	.30	.30
11.1	10.6	18.0	20.40	17.90	.22	.30	.71	.32	.32
12.8	15.8	26.9	21.59	19.09	.31	.42	.76	.34	.42
14.3	22.5	38.3	22.79	20.29	.42	.56	.81	.36	.56
16.0	30.9	52.6	24.00	21.50	.55	.73	.86	.38	.73

Shear at base of stem = $1/2 \times (16.0)^2 \times 0.045 = 5.80$ k
 $V_u = 1.70 \times 5.80 = 9.86$ k

$f_v = 9.86 / (12 \times 21.50) \times 1000 = 38$ psi < $f_{v,allowable} = 100$ psi (OK)

FIRM:Your Firm
MADE BY:KJH DATE:05-21-2006
TITLE:Example RETWALL calculation

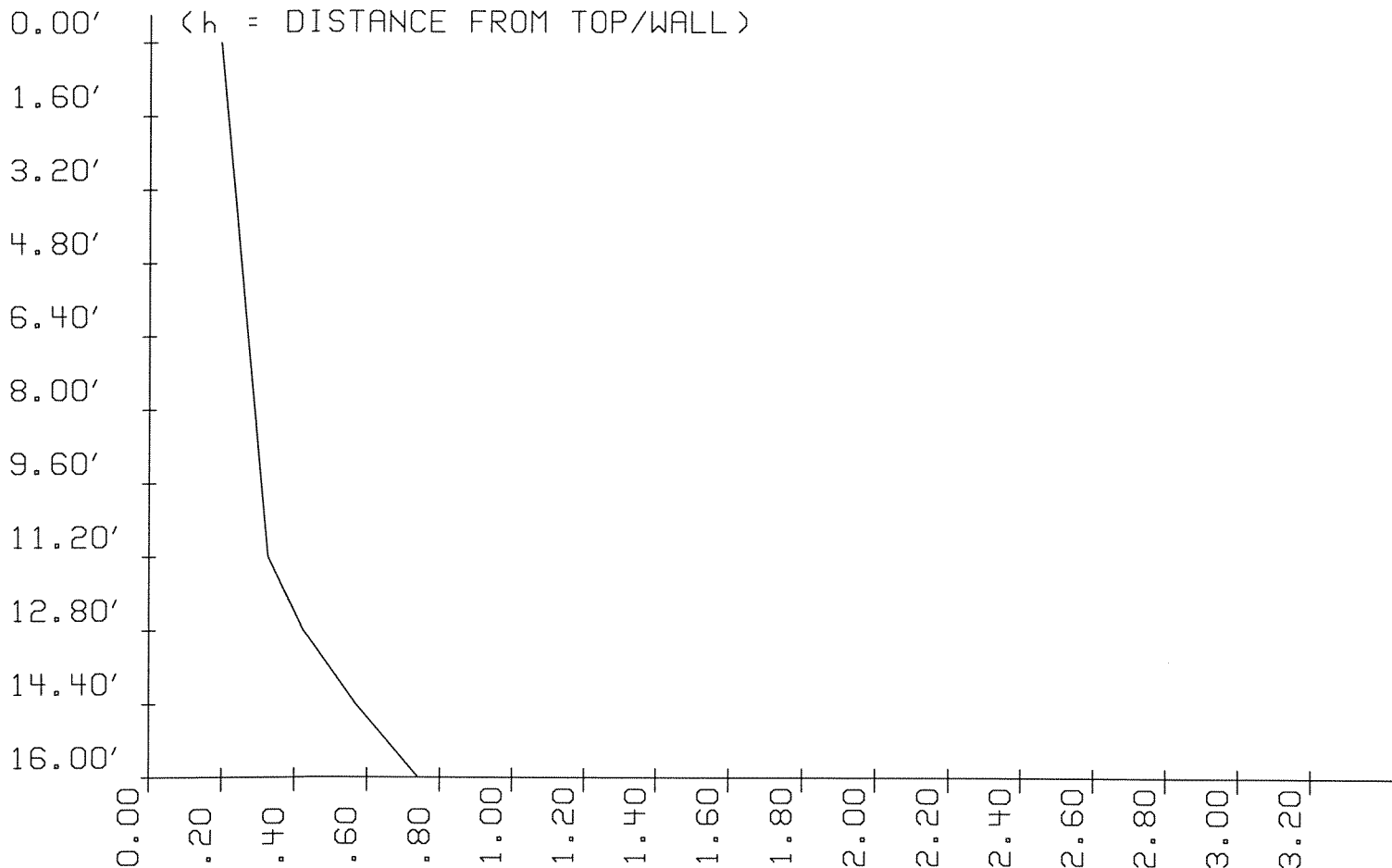
JOB NO.
CHECKED BY:

SHEET NO: 8
DATE:

=====

RETAINING WALL DESIGN:WINGWALLS

STEM DESIGN:



REINFORCEMENT REQ'D IN BACK FACE (SQ. IN./FT)